

Monthly changes of collembolan population under the gradients of moisture, organic carbon and nitrogen contents in a sub-tropical forest soil, Manipur.

W. Mema Devi ¹, Th Binoy Singh² and L. Joymati Devi ³

¹Deptt of Zoology G.P. Women's College, Imphal, India

²School of Life sciences, Manipur University, Imphal, India

³Dept. of Zoology D.M. College of Science, Imphal, India

Abstract

Population study of collembola for one calendar year was made in relation with moisture, organic carbon and nitrogen contents of a sub-tropical forest floor upto 0-10 cm. soil layer. Soil moisture content played important role and developed a significant correlation ($p > 0.01$) with the monthly population density of collembola. With increase carbon and nitrogen contents also observe increase population density indicating collembola's active participation in the release of these two nutrients from litter through decomposition and its incorporation in soil fertility.

Keywords: collembola, moisture, organic carbon and nitrogen.

INTRODUCTION

Undisturbed forest soils are naturally fertile soils. Without any manipulation by man they maintain the fertile nature year after year. This is due to the fact that soil animals present inside the soils make them fertile through the processes like decomposition, mineralization, nutrient cycling etc. Collembola are among the dominant soil animals in all types of soil. Their high number throughout the organic layer in the soil indicates that they take part in many phases of decomposition (Hagvar, 1982). Collembolan communities are known to be vertically structured having both morphological and physiological adaptations for living in their preferred microhabitats (Verhoef, 1978). Recent studies on soil microarthropods specially on collembola and acarina from various parts of the world have convincingly proved about their dominant role in soil formation, litter decomposition and nutrient cycling. Most species of collembola are small and quite susceptible to desiccation. However, their high number, activities even at low temperature and relatively omnivorous habits suggest that collembola are of great importance in soil formation (Kunett, 1976). Darlong et al. (2010) knowing the importance of soil fauna particularly microarthropods urged the need to do more research work on soil fauna, in India.

Keeping a view about the above facts the present study has taken up to investigate the role of moisture, organic carbon and nitrogen contents of soil to the monthly population fluctuation of collembola in a forty years old sub-tropical forest at Phayeng, about 15 Km. from Imphal, capital city of Manipur (India). The present paper will also highlight that out of the three parameters taken which one is the most controlling factor of the collembolan population

fluctuation.

MATERIAL AND METHODS

The present investigation was carried out for one year, from May 2009 to April, 2010 in a subtropical protected forest situated at Phayeng, Manipur. Soil samples were collected on monthly intervals using cylindrical core sampler of size 5.5 cm. in diameter and 10 cm in height having a surface area of 23.76 cm². Three study sites were demarcated with 100 m difference in height. Site I being the foot of the forest. On every sampling date three replicates from each study site were collected randomly and brought to the laboratory for extraction of soil animals as soon as possible.

Out of the various physical factors only soil moisture content, total nitrogen and organic carbon content were considered for the present investigation. The soil moisture content was analyzed by gravimetric method as given by Misra (1968). Soil total N and organic carbon were calculated by acid digestion kjeldahl procedure given by Anderson and Ingram (1993).

Extraction was continued for seven days and extracted animals were collected and all the collembolas were sorted out and counted month wise. Correlation coefficient analysis was done between population of collembola and soil parameters.

RESULTS AND DISCUSSIONS

The monthly population fluctuations of collembola for the three study sites were illustrated in Table-I. Highest population densities of $214 \times 10^2 \text{ m}^{-2}$ and $244 \times 10^2 \text{ m}^{-2}$ were recorded during the month of August in site-I and site-II respectively, but in site-III it was in the month of July being $231 \times 10^2 \text{ m}^{-2}$. Fig-1, 2 and 3 showed the monthly values of soil moisture content, organic carbon and total nitrogen content of the soil respectively.

Soil moisture content was found to play the most vital role among the three parameters of the soil for the present investigation in the distribution and fluctuation patterns of soil microarthropod population specially collembola. In the present investigation the soil moisture content recorded at 0 – 10 cm soil layer exhibited high significant positive correlations with collembolan population density

Received: Revised Accepted

*Corresponding Author

W. Mema Devi
Deptt of Zoology G.P. Women's College, Imphal.

Email: memawaikhom@yahoo.com

($p > 0.01$) Table 2. Durant and Richard (1966), Hazra (1978) and Reddy (1984) were also observed a positive correlation of soil moisture with collembola and acarina. Badejo and Van straalen (1993) also reported positive correlation between collembola and abundance of soil moisture. The findings of the above workers were

in accordance with the findings of the present investigation. In the present investigation, maximum soil moisture content (July, Aug) recorded falls during rainy months corresponded with the maximum population densities of collembola were of the same opinion with Nijjima (1971) and Badejo et al. (1998).

Table 1. Monthly fluctuations of the population density of collembola of the three study sites at 0 – 10 cm soil depth (Numbers x 10² m⁻²)

Site-I	May	June	July	Aug	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Site-I	199±2.9	178±2.8	210±7	214±11.6	206±21.5	200±12.1	172±4.6	54±1.7	79±3.2	71±2.3	185±4.3	126±1.5
Site-II	126±2.5	144±2.2	252±1.5	244±5.3	235±1.5	199±1.2	195±4.1	84±1.5	67±1.1	54±1	109±1.5	84±2.5
Site-III	113±2	122±2.6	231±1	197±1.1	138±3	227±3	130±2.6	105±4	101±1.1	85±1.7	117±1.1	138±3

Fig 1. Soil moisture content (%) of the three study sites at 0-10cm layer during different months of the study period

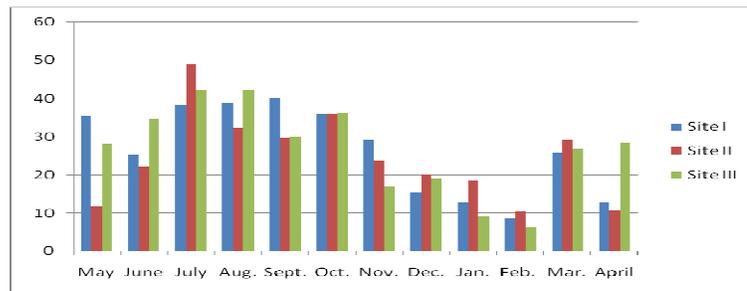


Fig 2. Soil organic carbon content (%) of the three study sites at 0-10cm layer during different months of the study period.

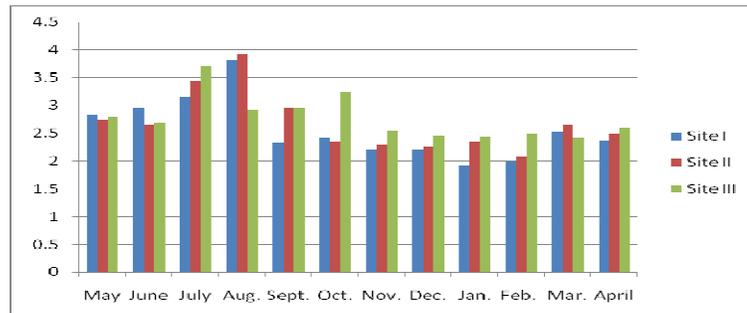
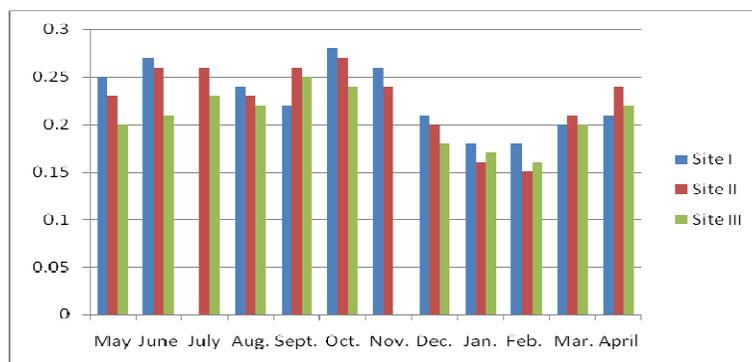


Fig 3. Soil Nitrogen content (%) of the three study sites at 0-10 soil layer during different months of the study period.



The soil organic carbon contents of the three study sites were comparatively more or less similar and it may be due to the fact that all three study sites were situated under the cover of the same forest with similar vegetation, similar amount of rainfall, temperature and decomposition rate. Soil organic carbon contents were recorded maximum during July and August i.e. during wet rainy months and minimum were recorded during dry winter months in all the three

study sites (fig-2). This may be due to higher percentage of moisture and other favorable microclimatic conditions which enhance the decomposition rate during rainy months. Soil organic carbon content exhibited a strong positive correlation with collembolan population ($p > 0.01$). The quantitative increased of population with increased concentration of organic carbon has been reported by Banerjee & Sanyal (1991), Ghose (1995), Sanyal et al (1999) etc. in different

ecosystems. It is highly probable that the total concentration potential of food as measured by the percentage of organic matter was of

profound importance in controlling the distribution of soil microarthropods specially of collembola.

Table 2. Correlation coefficient between collembola and three soil factors of the three study sites.

	Variables (%)	Soil layer (am)	r	df	t	p
Site I	Soil moisture	0-10	0.865	10	5.47	> 0.01
	Organic carbon	0-10	0.681	10	8.62	> 0.05
	Nitrogen	0-10	0.476	10	1.71	< 0.05
Site II	Soil moisture	0-10	0.808	10	4.35	> 0.01
	Organic carbon	0-10	0.841	10	4.91	> 0.01
	Nitrogen	0-10	0.748	10	3.57	> 0.01
Site III	Soil moisture	0-10	0.863	10	5.40	> 0.01
	Organic carbon	0-10	0.736	10	3.43	> 0.01
	Nitrogen	0-10	0.508	10	1.868	< 0.05

In the present investigation the total nitrogen content showed a positive significant correlation in site-II only (Table 2) but in site – I and site – III no significant relationship were maintained with collembolan population. It may be suggested that some species of collembola were using the same available niche in the soil with other soil fauna including acarina and when other species dominant, collembola could not maintain a positive correlation with total nitrogen available in that particular microhabitat and microclimatic conditions.

From the above findings it can be pointed out that out of the three parameters soil moisture content and organic carbon content played similar important roles in controlling the population densities of collembola as they showed high significant correlation with collembola population. However, with nitrogen content collembola population could not develop a positive correlation at site-I and site-III though nitrogen is also an important parameter in controlling the population fluctuation of collembola. However, number of collembola increased with increased carbon content and nitrogen content of the present study clearly indicated their active participation in litter decomposition and hence soil fertility. Combining the three factors, moisture content provided a favorable habitat for reproduction of collembola and hence increased decomposition with corresponding released of carbon and nitrogen.

ACKNOWLEDGEMENT

The study was supported by a research grant from UGC in the form of Minor Research Project.

REFERENCES

- [1] Anderson, J.M. and J.S. Ingram | Eds. 1993 Tropical soil Biology and fertility : A hand book of Method, U.K., C.A.B, International.
- [2] Badejo, M.A. and N.M. Van Straalen, 1993. Seasonal abundance of springtails in two contrasting environment, *Biotropica* 25: 222-228.
- [3] Badejo, M.A., T.I. Nathaniol and G. Tian 1998. Abundance of

springtails (Collembola) under four agroforestry tree species with contrasting litter quality, *Biol, Ferlel, Soil.* 27:15-20.

- [4] Banerjee, S. and A.K. Sanyal, 1991. Oribatid mites as bioindicator of soil organic matter. *Proc. 10th Int. Soil Zool Cooq.* Bangalore : 877-880.
- [5] Darlong, V.T., S.J.S. Hattar and J.R.B. Alfred, 2010. Soil fauna studies in the rain forest of North East India: Knowledge gaps and areas of research priorities wwiienvis.nic.in/rain_forest/chapter17.htm.
- [6] Durant, J.A. and F.C. Richard, 1966. Some arthropods of forest floor in Pine and hardwood forests in South Carolina Piedmont region. *Ann. Ent. Soc. Am.* 59(1): 202-207.
- [7] Hagvar, S. 1982, Collembola in Norwegian coniferous forest soil-I relation to plant communities and soil fertility. *Pedobiologia* 24: 255-196.
- [8] Hazra, AK 1978, Ecology of collembola in a deciduous forest floor of Bhirbhum district, West Bengal in relation to soil moisture, *Oriental Insects* 12(20) 265-274.
- [9] Kunett, W. 1976 "Soil Biology" Faber and Faber Ltd. London pp. 483.
- [10] Misra, R (1969) Ecology work book, Oxford and IBH Publication. Co. Kolkatta-India.
- [11] Nijjima, K. 1971. Seasonal changes in Collembolan population in a warm temperate forest of Japan, *Pedobiologia* 11:11-26.
- [12] Reddy, M.V. 1984. Ecology of soil and letter inhabiting arthropods. *Indian rev. Life Sci.* 4:169-217.
- [13] Sanyal, A.K., Kundu, B.G. and Roy, S. 1999. Records of the Zoological Survey of India occasional paper 177.
- [14] Verhoef, H. 1978. An ecological study of water relations in Collembola. P. Free University of Amsterdam, Amsterdam pp.105.